Small-scale Forestry (2010) 9:297–316
DOI 10.1007/s11842-010-9117-z

RESEARCH PAPER

Farm Forestry Prospects Among Some Local Communities in Rachuonyo District, Kenya

Mark Appiah · Ari Pappinen

Accepted: 9 April 2010 / Published online: 27 April 2010

Abstract Deforestation and degradation of productive lands are serious threats to the sustainability of forestry/agricultural practices in Kenya. In the last two decades farm forestry (FF) has been promoted through pilot projects among local communities as an example of sustainable land use. However adoption of FF is limited outside the project locations because FF improvement measures focused mainly on biological (e.g. succession, biodiversity and traditional industrial timber production) and technical concerns (e.g. material input delivery such as providing free tree seedlings for field planting) rather than local values, and interests and the constraints facing farmers. This study examined the local farm priorities and constraints and the prospects for the wider implementation of farm-level tree planting in four communities in Rachuonyo District. Using interviews with 597 randomly selected household heads, the study assessed farmer's production assets and activities, land tenure, priority tree species and the constraints to growing trees on farms. Results show that farm labour is represented by a young population, 56.3% under the age of forty. They are mainly engaged in small-scale mixed cropping integrated with multipurpose trees and some livestock. Tree products contribute about 32% to household cash income, more than any other source (agricultural products, labour sales, etc). Females were more often household heads and had considerable influence over productive activities, making them an important target group in FF development. Farmers preferred exotic tree species due to their ability to provide short-term cash income, fuel and shade. Farmers' concerns included population pressure on limited farmlands and the problem of credit for agricultural inputs.

M. Appiah (✉)
VITRI, Viikki Tropical Resources Institute, University of Helsinki, P.O. Box 27
Latokartanonkaari 9, 00014 Helsinki, Finland
e-mail: Mark.Appiah@helsinki.fi

A. Pappinen
North Karelia University of Applied Sciences, Tikkarinne 9, 80200 Joensuu, Finland
e-mail: Ari.Pappinen@joensuu.fi

Given the feeling of secured tenure arrangement and influence of tree products on the household economy, farmers are likely to invest more in efficient land uses such as FF if consideration is given to local priorities.

Keywords Farm forestry development · Forest products · Income · Livelihood · Preferred species · Target group

Introduction

Kenya is classified among the countries with low forest cover of less than 2% of the total land area (FAO 1993, 2005). Covering a land area of about 569,140 hectares the majority (80%) is arid lands and desert. Only 20% of the land area is classified as productive and under agriculture, forests and nature reserves (FAO 2005; Müller and Mburu 2009) and much of this is under the threat of deforestation and degradation. Forest loss in the primary forest alone between 2000 and 2005 was 2,400 hectares per year (FAO 2005) and this is rapidly increasing particularly in western Kenyan. Unprecedented human demand for forest products (e.g. fuel wood, poles, timber, herbs) (Kenya Forestry Master Plan 1994; Mulinge and Mueller 1998; Brooks et al. 1999), and conversion of forest to agricultural land and subsequent frequent activities of tilling, cropping and grazing are causing more loss of forests and exposing the topsoil of productive lands to soil erosion (Sanchez and Jama 2000). As a result, there is soil fertility loss and consequently a declining agricultural productivity (World Bank 1996; Maithya et al. 2006). This combination of poor agricultural practices along with deforestation is resulting to the desertification of many areas making farming in these areas less sustainable and causing a dramatic decline in non-wood and wood resources needed to satisfy fuel, construction and other domestic needs of local people. Access to additional land for farming has become difficult in Kenya due to the increase in demand for land from a population that is growing rapidly at a rate of 6.6 and 1.8% in urban and rural areas respectively (Central Bureau of Statistics 2002). The population growth rate is higher than the growth rate in agricultural output. Consequently, both per-capita food production and incomes have declined resulting in recurrent food shortages and worsening rural poverty (Maithya et al. 2006; FAO 2007a). Hence, improving the use of land and agricultural practices towards sustainable levels is a major challenge in Kenya (Maithya et al. 2006; Nyangena 2008; Oluoko-Odingo 2008).

Planting of trees along with agricultural crops (termed here as farm forestry (FF)) is considered as a feasible solution to more sustainable land uses (FAO 2007b). Nearly every developing country around the globe, including Kenya, is practicing some form of farm forestry (e.g. McCarthey 2004; FAO 2007b), which ranges from woodlots(e.g. Ramadhania et al. 2002), alley farming (e.g. Mungai et al. 2001), plantings around homestead (home gardens) (e.g. Nair 2001), boundary planting, to wide-space planting of trees in croplands, and in pastureland (Torquebiau 2000). These practices provide the opportunity for farmers to harness the potential of the various resources within a production unit and provide a means of livelihood diversification (Muchiri et al. 2002) which serves as a safety net for local people.

For instance, trees planted within agricultural landscape can help to increase wood and non-wood supplies such as medicine, fodder, construction material and food, while contributing significantly to soil fertility, erosion control, microclimate amelioration and environmental protection (e.g. Muchiri et al. 2002). Additionally, tree-based systems help to reduce deforestation. Murniati et al. (2001) found that local people who diversified their agricultural crop systems to include timber tree species used the native or primary forests less intensively thereby reducing pressure on the primary forests and also reducing the exploitation of nearby conservation or protected areas. Recent work has also highlighted the importance of tree-base farming systems in C sequestration and biodiversity conservation (e.g. Kirby and Potvin 2007) and suggested that tree-based systems are much better at accumulating carbon, above and below ground, than pure agriculture.

It is for these benefits that the Government of Kenya, over the last decade, had sought to promote land use systems integrating trees with crops and/or livestock aimed at reducing deforestation, and improving soil and water conservation practices (Pretty 1995; David 1997; Nyangena 2008) including the farming areas in Rachuonyo District in the western part of the country which is of interest in this study. In this effort, other international organisations such as the International Centre for Research in Agro-forestry (ICRAF) and the Tropical Soil Biology and Fertility Institute have also promoted alternative soil fertility replenishment technologies with farmers in Western Kenya (Maithya et al. 2006) including improved tree fallows using different tree species (Jama et al. 1999; Sanchez and Jama 2000). However, success of enhanced incorporation of tree species into agricultural landscapes as measured by adoption outside of supported project locations has been limited (Kiptot et al. 2006). The main reason is that, while some of the project measures have focused mainly on biological (e.g. succession, biodiversity and traditional industrial timber production) concerns, other attempts have been guided by single sector-based policy and development intervention approaches (Kaudia and Omoro 2001). Under this sector-focused model, projects relied on a policy of service and material input delivery by providing free tree seedlings, paid training, cash payments for planted seedlings, and technical information to encourage farmers to adopt farm forestry (Enters and Hagmann 1996). Extension workers had the role of delivering prescribed messages to farmers who were assumed to be ignorant and needed the prescriptions to solve their farming problems. It is typical of many development projects carried out in Africa (Barrett et al. 2002) that they ignore or overlook, farmers' perceptions of valued trees, their priorities and the constraints they face in developing tree resources (e.g. Chambers and Richards 1995; Danida 1995; Biot et al. 1995; Appiah 2001; Brown 2002; Blay et al. 2008). The approach is often top–down and lacks farmer participation in the planning process (Biot et al. 1995; Brown 2003). Consequently, the supposedly improved practices introduced are either abandoned or neglected by the local communities after external support is terminated (Lutz et al 1994; Nyangena 2008).

Nevertheless, the situation is changing. Efforts to enhance adoption of farm forestry by development agents have started drawing on local knowledge, views and priorities. An example is a livelihood project in Rachuonyo District that is

financially supported by the Finnish Government through the Ministry of Foreign Affairs of Finland Development Cooperation. Aiming at high adoption rate, this study was conducted to examine the local farm priorities and constraints and the prospects for the implementation of farm-level tree planting projects in four communities in Rachuonyo District. Specifically, the study assessed farmer's production assets and activities, land tenure, priority farm tree species and the constraints facing them that could hinder tree growing on farms.

Research Methods

Study Area, People and Livelihoods

The study was undertaken in Rachuonyo District in Kenya involving the local communities of Kagwa, Kamser Seka, Rambira, and Seka Kagwaten (Fig. 1). The communities fall within Latitude 0° 22′ 0S and Longitude 34° 38′ 60E. The climate and topography are heterogeneous, with an average annual rainfall of about 1,700 mm and a March-to-June rainy season (Conelly and Chaiken 2000). The altitude ranges between 1,450 and 1,650 m. The mean monthly temperature is 18.7°C (Müller and Mburu 2009). February is the warmest month of the year, with a mean maximum daily temperature of 28.3°C and mean minimum daily temperature of 10.8°C. July is the coolest month, with a mean maximum daily temperature of 25.4°C and mean minimum daily temperature of 10.2°C. The main soil types include Acrisols and Nitisols. The main cropping season starting during the long rainy season from late February and runs through to June. The district experiences the driest spells during the months of December to February and again from June to August during which period both agricultural and livestock activities are at minimum (Radersma et al. 2004).

Generally human population is high in these communities. The District population is 371,021 of which 176,124 are males and 194, 897 are females and this is projected to rise to 378,895 in 2010 (mid-term) and 395,147 in 2012. The population density is high with an average of about 230 individuals per square kilometre (GoK 2008). The Luo and kisii-speaking people are the main inhabitants of the communities who are mainly farmers. The cultivation of food crops is dominated by maize, sorghum, cassava, beans and bananas. Cattle, sheep, goats and poultry keeping dominate the livestock sector. Fishing is also an important economic activity and is practiced in rivers, ponds and Lake Victoria (GoK 2008).

The area falls within the agro-climate zone where land is suitable for farming (Conelly and Chaiken 2000) and has the potential to be one of the most productive agricultural areas in all of Kenya. Unfortunately, this is not the case. Farming is mainly low input—low output farming, practised on small farms of less than 2 hectares for small-scale farmers and less than 4 hectares for large-scale farmers (GoK 2008), due to a population pressure. As a result, there are more people living below the poverty line. The national statistics show that over 50% of the population in many of the districts in western Kenya including Rachuonyo lives below the poverty line of 1,240 Ksh per adult per month (equal to about US$ 16) (Central

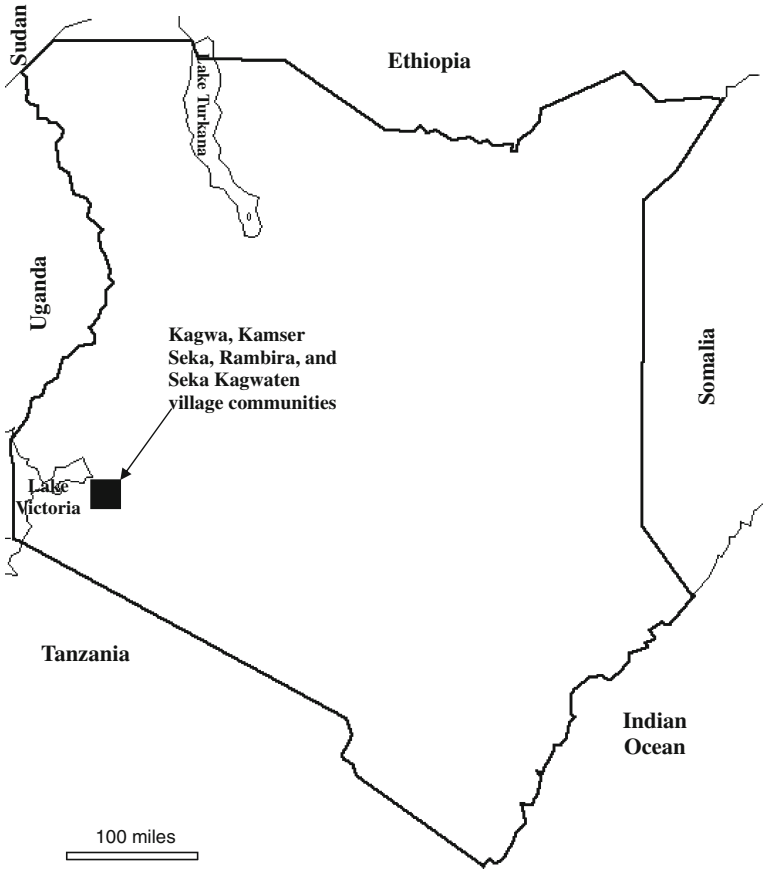

Fig. 1 Location of study communities in Rachuonyo District in Kenya

Bureau of Statistics 2002, 2006). Levels of deforestation and land degradation are high resulting mainly from poor farming practices, cattle grazing, fuel wood extraction and charcoal burning (Guthiga et al. 2006). These activities contribute to loss of vegetation cover and exposure of the productive environment to severe degradation, a trend that threatens future livelihoods of people in the District. In order to reverse deforestation and land degradation farmers are encouraged to integrate more trees into their farming system. Supported under the Registered Land Act (Cap. 300) of 1963 the rights of control and the rights of use of planted tree are both vested in the landowner and the landowner determines if an individual can use the trees growing on his or her land (GoK 1989).

Data Collection

Data for this study were collected in 2006 mainly through a survey using personal interviews of 597 household heads in the Kagwa, Kamser Seka, Rambira, Seka

Kagwaten local communities. The household heads were selected at random using the District register of community settlements (e.g. Kiptot et al. 2006) and interviewed with a semi-structured questionnaire (see "Appendix"). A semi-structured questionnaire was used because it provides the opportunity to elicit information of a range and depth that is not attainable with a totally structured questionnaire (Freudenberger 1994; Chambers 1997; Appiah et al 2007; Mbuvi and Boon 2009). The questionnaire was first developed and tested on four household heads for clarity. Minor modifications were made based on the feedback before the questionnaire was administered to the full sample. The questions were centred on (i) demographic aspects; personal background of the farmers including gender, age, household size and education, which reflects human capital (David 1997), (ii) livelihood options; agriculture, forestry practices, other income generating activities, (iii) farmers interests and priority farm tree and crop species and their uses (iv) farmers perception on the constraints to the adoption of improved farm forestry practices, and (v) farmers land tenure arrangements and security; and feeling of ownership of trees resources. With respect to household income, respondents were asked to give an estimation of how much they earned in total per month through the selling of agricultural products (millet, beans, maize, groundnut, cassava; livestock: sheep, cattle, goats, chicken, fish etc.), forest products (firewood, charcoal, fruit, flowers, spices, ropes, woodcrafts, honey, medicine, etc), labour sales and from other cash streams such as dressmaking, domestic help, barbering, hairdressing, carpentry.

The interviews were conducted in the local dialect (Kisii) of the respondents and responses written down in English during the interviews. The meeting dates and time for the interviews were arranged with the selected farmers beforehand. Most of the farmers who were sampled kept their appointment for the face-to-face interview. In only a few cases the appointment date and time had to be rescheduled because some of the respondents had unexpected assignments. Thus, the sample response rate could be considered as 100%. The responses most relevant to the objectives of this paper are presented. Descriptive statistics (Frequencies, percentages, mean, ranks) generated through the Statistical Package for Social Scientists (SPSS) software, were used to analyse the data. Regression was used to test the relationship between household income and other characteristics of household heads (gender, education and occupation).

Survey Findings

Household Composition

The population was estimated at an average of 2,569 persons in 597 households. The mean household size was 4.3 estimated considering all members who reside in the household and including those who were temporally absent at the time of the survey. The average number of female-headed households substantially exceeds that of the male-headed ones (Table 1). The female household heads were mainly either single ($n = 190$), widowed ($n = 90$), or divorced ($n = 59$). Within the sample of

Table 1 Socio-economic characteristics of farmers from Kagwa, Kamser Seka, Rambira, and Seka Kagwaten communities in Rachuonyo District, Kenya ($N = 597$)

Socio-economic characteristics	Frequency (f)	Percentage (%)
Gender		
Male	148	25
Female	449	75
Marital status		
Married	197	33
Single	179	30
Divorced	149	25
Widowed	72	12
Age group (years)		
Unsure	60	10
15–20	30	5
21–30	131	22
31–40	113	19
>40	263	44
Household size		
1–3	210	35
4–6	200	34
7–9	128	21
>10	59	10
Educational status		
None	0	0
Primary	537	90
Secondary	48	8
Post secondary/college	12	2
University	0	0
Land tenure security		
Secured	585	98
Unsecure	12	2

household heads, 46% were between 15 and 40 years old and 44% above 40 years. Some of them (10%) were not sure about their date of birth because they did not keep accurate records (Table 1). The majority of the household heads had formal education up to primary school level. This means they are literate, but are not necessarily able to handle very complex issues. A further 8% had education up to the secondary school level; they are literate and can handle issues that are more complex. Only a few (2%) of the respondents had a college level education. None of the respondents had a university degree.

Incomes Levels and Sources and Land Tenure

The average household monthly cash income from various informal occupations varies across households (i.e. $Sum\ of\ Squares = 1.044$, $df = 3$, $X^2 = 0.348$,

$F = 16.529$, $P < 0.001$) and even between male and female-headed households and ranged from 1,050 to 2,050 Kenya shillings (Ksh) (US$ 14.6–30.6 in 2006). The cash contributions from the sale of tree products (firewood, charcoal, fruit, flowers, spices, ropes, woodcrafts, honey, medicine, etc.) accounted for about 32% of the total household cash income. While the income from crops and livestock (millet, beans, maize, groundnut, cassava; livestock: sheep, cattle, goats, chicken, fish, etc.), which is the most common source of income for the majority of the people, was about 2,020 Ksh (US$ 28.5) per month. The third most common income source is the sale of labour. Among family members, individuals provide labour under reciprocal arrangements during land preparation and harvesting and provide labour for a fee to non-family members. There are also some of the households that derived most of their income from non-agricultural sources including domestic help, carpentry etc. Regression was used to test the relationship between household income and other characteristics of household heads (gender, education and occupation). Generally, there was an association between household income and the gender, education and occupation type of the household heads (i.e. $r^2 = 0.45$, $X^2 = 24.01$, $df = 3$, $P < 0.001$ $n = 597$). A negative correlation was observed between the gender of household head and household cash income (*Coeff.* $b = -0.28$, SE $= 0.04$, $P < 0.001$). Household cash income was higher for the households headed by women than for the ones headed by men, with the women household heads earning a mean of 2,095 Ksh (US$ 29.1) (SE $= 0.006$) per month while their male counterparts earned an average of 1,559 Ksh (US$ 21.6)(SE $= 0.068$) per month. This differential of income may be due to the women's better abilities to trade in agricultural and forest products observed in this study as an important livelihood activity. Also, income was positively correlated with education level of household heads (i.e. *Coeff.* $b = 0.19$, SE $= 0.01$ $P < 0.001$) and negatively correlated with the occupation of households heads (i.e. *Coeff.* $b = -0.12$, SE $= 0.02$ $P < 0.001$). As expected, level of education of head of households had a positive influence on income level. Respondents who were better educated made higher cash income from their livelihood activities and vice versa. In term of occupation, household income was highest for the occupational activities related to the trading of forest products with the lowest income related to the other category representing dressmaking, house helper and barbering.

The majority of the respondents appeared to have secured land holdings (Tables 1, 2). As they explained, some (91%) had unwritten land ownership rights under the customary tenure bound through traditional rules, where they have guaranteed rights of access to their land and other tree resources on the land. Others (9%) had a sub-tenant status where they worked on land acquired through sharecropping with a landowner.

Agricultural/Farm Forestry and Role Sharing

The participation of the household heads in the production activities were analysed (Table 3). The members of a household were the main source of farm labour. Remarkably, females also play a major role in the household productive process

Table 2 Monthly cash income levels of households from various livelihood activities in Kagwa, Kamser Seka, Rambira, and Seka Kagwaten communities in Rachuonyo District, Kenya ($n = 597$)

Livelihood activities	Frequency (f)[a]	Percentage frequency	Cash income (×1,000 Ksh)	Cash income US$ in 2006
1. Sale of agriculture products	393	66	2.05	28.5
2. Sale farm forest product	163	27	2.20	30.6
3. Provision of farm labour	27	5	1.56	21.7
4. Other informal income sources	14	2	1.05	14.6

[a] Represents the frequency of head of households with income from the listed livelihood activities

Table 3 Responsibilities of household heads in Kagwa, Kamser Seka, Rambira, and Seka Kagwaten communities in Rachuonyo District, Kenya for various production activities ($n = 597$)

Role sharing in productive activities	Males (%)	Females (%)	Both (%)	Entire family (%)	Total (%)
Land preparation	23	38	4	35	100
Choosing farm crop and tree species	21	64	13	2	100
Planting and management	23	35	16	26	100
Harvesting	5	17	32	46	100
Marketing farm products	23	75	2	–	100
Responsibility over income	21	54	25	–	100

from land utilisation (which was usually the task of the man) to generating farm income. They had direct control over production activities, and profit from farming practices and played key roles in determining the kind of crop or species to be included in the farming system. The household heads were mainly engaged in rain-fed agriculture, which was for subsistence only. Farm sizes ranged from 0.3 to 2.5 hectares. Generally, five major crops were cultivated mainly in the field and around the homestead (Table 4). Maize (95%), Millet (92%), groundnuts (43%), beans (42%) and cassava (36%) are the most commonly cultivated crops in different combinations, depending on farmers' preference. Although not reported, fruit trees such as mango and avocado were also seen in the systems, but perhaps not planted intentionally. The keeping of livestock is an important livelihood activity for the respondents. Sheep, goats, cattle, and chickens, predominantly of local breeds are the main animals kept by households in the studied communities. The cattle-owning households were predominantly male-headed ones (Table 4). Additionally, random planting of multipurpose tree species (e.g. *Grevillea robusta*, *Eucalyptus* spp., *Moringa* spp., *Jacaranda* spp., and *Calliandra* spp.) together with agricultural crops (e.g. maize) around homestead and woodlots of mainly exotic species including *Grevillea robusta*, *Eucalyptus* spp. were the most common farm forestry activities (Table 5). Although not reported, indigenous trees such as *Cordial abyssinica,*

Table 4 Five main crops and livestock managed by some farmers from Kagwa, Kamser Seka, Rambira, and Seka Kagwaten communities in Rachuonyo District, Kenya ($n = 597$)

Type of crop/livestock	% Involved in production			% Not involved in production		
	Male (M)	Female (F)	Total M&F	Male (M)	Female (F)	Total M&F
Crops						
Maize (*Zea mays*)	22	73	95	3	2	5
Millet (*Eleusine coracana*)	22	70	92	2	6	8
Groundnuts (*Arachis hypogaea*)	10	33	43	15	42	57
Beans (*Vigna sinensis*)	11	31	42	14	44	58
Cassava (*Manihot esculenta*)	7	29	36	18	46	64
Livestock						
Chicken	18	53	71	7	22	29
Goat	22	43	65	9	26	35
Sheep	18	30	48	7	45	52
Cattle	7	8	15	18	67	85

Table 5 Five main farm-forestry tree species favoured by farmers from Kagwa, Kamser Seka, Rambira, and Seka Kagwaten communities in Rachuonyo District, Kenya ($n = 597$)

Priority order	Species	Local/common name(s)	Species value
1	*Grevillea robusta*	Omokabiria, Bolebolea	For making furniture, fencing, charcoal, pole, shade. Used for external window joinery as it is resistant to rotting
2	*Eucalyptus saligna*	Omoringamu Bao, Ndege	For poles, fuelwood, for sale, domestic construction. Depending on the use for which the timbers are required, one can harvest from 8 years on
3	*Calliandra* spp.	Calliandra	Use to reduce soil erosion. Used as nitrogen fixing species for soil fertility improvement, Foliage used as fodder and green manure
4	*Moringa oleifera*	Mlonge, Mronge, Mrongo, Mzunze	Seeds are eaten. Foliage eaten as greens in salads and for seasoning. Foliage used as fodder and green manure. Young branches are fed to livestock. Leaves pounded up and used for scrubbing utensils. The flowers, leaves, and roots used as medicine. Not reported by respondents, the oil can be extracted from seeds for lubricating purposes
5	*Jacaranda Mimosifolia*	Jacaranda	Harvested for gum, resin and oils used in various cosmetics and industrial processes. Exploited for carving. A single acres of land can carry 80,000 of the hardwood species

Erythrina tomentosa, and *Croton macrostychus*, were also seen in maize fields. These species were presumably left during land preparation.

Respondents' preferences for tree species are determined by several factors—suitability to providing micro-climate, perceived economic value, and ecological

Table 6 Best suited tree species for meetings various needs as indicated by farmers from Kagwa, Kamser Seka, Rambira, and Seka Kagwaten communities in Rachuonyo District, Kenya ($n = 597$)

Purpose	Best suited species	Family	Native or indigenous
1. Household cash income	*Moringa pterygosperma*	Moringaceae	Exotic
	Grevillea robusta,	Proteaceae	Exotic
	Jacaranda Mimosifolia	Bignoniaceae	Exotic
2. Medicine	*Moringa pterygosperma*	Moringaceae	Exotic
3. Ornamental	*Casuarina equisetifolia*	Casuarinaceae	Exotic
4. Supports the craft industry	*Jacaranda* spp.	Bignoniaceae	Exotic
5. Construction, furniture, timber, pole	*Grevillea robusta,*	Proteaceae	Exotic
	Eucalyptus spp.	Myrtaceae	Exotic
Supports fuel need /charcoal	*Grevillea robusta*	Proteaceae	Exotic
	Calliandra spp.	Fabaceae	Exotic
6. Support animal feeding (Fodder)	*Calliandra* spp.	Fabaceae	Exotic
	Moringa pterygosperma	Moringaceae	Exotic
7. Agricultural shade/protection	*Grevillea robusta*	Proteaceae	Exotic
8. Soil fertility, erosion control	*Calliandra* spp.	Fabaceae	Exotic
	Moringa pterygosperma	Moringacea	Exotic
	Casuarina equisetifolia	Casuarinaceae	Exotic

value. When asked the best-suited species for household cash income generation, the respondents indicated *Moringa pterygosperma, Grevillea robusta, and Jacaranda Mimosifolia* as preferred species. For shade on farms and fuel needs of local people *Grevillea robusta* was mainly mentioned (Table 6).

With the exception of 102, the majority (495) of people involved in the study had access to water for domestic and agricultural purposes. The main sources of water for nursery practices, livestock and household use, in the order of importance, is lake ($n = 154$), ponds ($n = 138$), river ($n = 104$) shallow wells ($n = 97$), spring ($n = 70$), roof catchments ($n = 32$). Only few (2) did not indicate any source of water for domestic and livestock use.

Constraints to Farm Forestry Adoption as Perceived by Farmers

The increasing reduction of land area under cultivation due to the division of land among the increasing numbers of households or family members was worrying for many farmers (61%, consisting of 40% females and 21% males) who think that it might militate against any efforts to develop farm forestry. Others (30%, consisting of 18% females and 12% males) mentioned inadequate credit facilities for purchasing farm forestry inputs as a major constraint. For another category of respondents (5%, consisting of 4% females, 1% males), the continued decline in agricultural output due to increased land degradation was a concern. Lastly, for

some respondents' (5%, consisting of 4% females and 1% males) their concern was the inability to carry out their farming practices in innovative ways due to the lack of information or poor education on improved practices.

Discussion

Household Heads in Decision-Making and Resource Management

Many of the household were headed by women. This is unusual considering other studies on household characteristics in Western Kenya (e.g. David 1997), where males are usually the heads and are the ones making decisions concerning productive and cash related activities (Okitoi et al. 2007). In this case, the women farmers interviewed were influential members of their home and in their communities. They played key roles in determining the kind of crop to be grown and were involved in decisions involving crop harvesting and marketing. This is in sharp contrast to the situation in many developing countries where women are still precluded from having direct control over land, production activities, decision-making and profit despite their significant role in areas such as agricultural/forestry production, gathering of forest products, processing, and marketing (FAO 1990; Mbuvi and Boon 2009). These findings suggest that engaging the untapped energy and abilities of these women, could lead to a lasting progress in farm development and tree management on farms in the studied areas. In fact women are twice as likely as men to be involved in agricultural innovative activities (Ogato et al. 2009).

The household was the main source of labour for production activities in these communities. Among family members, individuals provided labour under reciprocal arrangements during land preparation and harvesting. Labour was also provided to other non-family members for a fee and was a good a source of income for the households. Often most rural households depend on hired labour especially for land preparation and weeding (David 1997). The potential in this kind of labour arrangement is that it brings people together and could enhance the sharing of knowledge and collective action to adopt improved farm forestry practices as was noted by Nyangena (2008) during his study in Western Kenya on the adoption of soil conservation practices. According to Krishna (2001) such social network can foster cooperative behaviour that could ease labour scarcity problems, which is often a huge problem in the rural areas, and is expected to increase with agricultural intensification which may be labour intensive.

Land Tenure and Farm Forestry Activities

Remarkably, farmers feel secure about their land and tree tenure status, which has often been a major hindrance to tree planting and soil conservation practices in some areas in Kenya (Nyangena 2008) and one of the important underlying causes of forests and land conflicts in Africa and many parts of the developing world. The feeling of having tenure security gives farmers the assurance to undertake long-term

investment such as tree planting (Gebremedhin and Swinton 2003) and provides a good basis for farm forestry development.

Farm forestry practices mainly centred on scattered trees in field crops and around homestead on farm holdings up to about 2.5 hectares, as was also suggested by Dewees and Saxena (1995). These small holdings are the most common farms in the district (Republic of Kenya 2008) and in western Kenya generally (e.g. David 1997). Trees within the farming systems play critical livelihood role in many of the households interviewed, with trees providing multiple needs (e.g. income, shade, fuel, pole fodder, medicine, etc) and ecological benefits. For planting, the majority of farmers' preferred exotic tree species ones such *Grevillea robusta*, *Calliandra* spp, *Jacaranda* spp and *Moringa* spp, probably because of their high commercial value since they were managed for poles, fuel wood and other products which are normally sold to pay major household expenses (David 1997). Exotic species were mentioned as priority species by all the farmers even though there were some useful indigenous species in the area. These included *Cordial abyssinica, Erythrina tomentosa, Croton macrostychus, and Prunus africana*, (Imo et al. 2001) and they were certainly known to some of the respondents. *Cordial abyssinica* for instance are used for beehives, stools, mortars, well covers and as building timber (Castro 1991). This means that the selection of additional species for farm forestry or plantations needs to be carefully planned in consultations and collaboration with the farmers, and be based on the socio-economic values compared with local trees known to farmers. According to Wiersum (1991), this process may enhance the willingness of the farmers to accept the new species for cultivation and sustain the initiatives beyond external-assistance phase. It also mean that, popular tree species such as *Grevillea robusta*, *Calliandra* spp., *Jacaranda* spp. and *Moringa* spp. when well represented in agricultural landscapes can improve the livelihoods of farmers through the provision of fuel wood, poles for sale or construction, fodder, medicine to mention but a few. They can also provide environmental benefits. For instance Calliandra, one of the priority species, has been usefully used to reduce soil erosion (e.g. Shelton et al. 1991) and has the capacity to fix nitrogen into the soil and improve soil fertility (e.g. Macqueen 1991).

Income Sources and Priorities

Trading of harvested tree products accounted for about 32% of the total household cash income. In western Kenya, trading in products such as poles, firewood, charcoal medicines, gums and wild foods is a lucrative business (David 1997). Around 8% of Kenyans are involved in or supported by the charcoal trade alone. In other parts of rural Africa, non-farm activities including trading in forest products contribute as much as 30%–50% or more of household's income (Ellis 1998). This echoes the importance of trees in the livelihood and development of local people, and suggests that when trees are well integrated into farming systems they could help to reduce reliance on natural forest for products consequently reducing over exploitation (Kokwaro 1993; Beentje 1994; Hesselberg and Yaro 2006).

Although tree products contributed more to household cash income than any other source (agricultural products, labour sales, etc), the majority of the households depended on agricultural products for cash income. Thus, agricultural production was a priority livelihood activity regardless of peoples' earnings from non-agricultural sources as was also noted by other studies (e.g. David 1997). This suggests that farm forestry development should be based on developing the traditional systems that provides a 'safety net' which ensures that some money can be earned, little as that may be, all the time to meet household needs.

Generally, cash flows from agricultural and tree products were low when compared to the total cash expenditure of about 3,891 Ksh (US$124.7) per month reported for households in western part of the country including the studied areas (David 1997). According to David (1997), most of the farmers' expenditure goes towards food and non-food necessities such as health, transportation, clothing, fuel, school fees, and other social obligations. Apparently, very little will be left for agricultural inputs such as seed material, hired labour, manure and tools. Therefore, supporting farmers to cope with limited cash in-flow should be an important factor to be considered in enhancing the adoption of improved farm forestry practices.

Constraints to Farm Forestry Development

The high and increasingly young population suggests that farm sizes that are already small may shrink further due to subdivision of land among grown children or relatives. Thus, farm sizes may be too small for the local people to be able to increase agricultural production and generate sufficient income for household needs. Consequently, investment in agricultural intensification, where farmers undertake permanent cultivation and employ techniques such as manuring and composting to maintain soil fertility (Conelly and Chaiken 2000) is very necessary.

Respondents recognised the lack of credit facilities as a major constraint to farm forestry development. The need for credit line has been extensively reported (e.g. Franzel and Scherr 2002; Franzel et al. 2002) but remains a top problem for farm forestry adoption in the study area. This further highlights that this constraint if not solved, the practice of tree-based systems will remain at experimental and project levels. There is therefore a need for credit facilities or government-provided financial incentives. Farmers, particularly women have limited or no access to funding (Ogato et al. 2009). The introduction of microfinance schemes to create access to grants and loans by the development agencies may help to improve the farm forestry activities, especially for women, and consequently, the quality of life for rural households.

Education is essentially a prerequisite for improving agriculture and consequently the living conditions of rural people. Household heads with relatively high educational qualifications were able to generate higher income from their occupations. In contrast, those who had lower qualifications were lower income earners. It suggests that education helped in the making of livelihood choices based

on informed decisions. Nearly all the head of households had very low level of education with still poor access to education in those areas. The local people, as they indicated in the survey, rely only on their skills from traditional practices and lacked the necessary skills to carry out farming practices in innovative ways. This support the view by Mbuvi and Boon (2009) that lack of education on skills such as tree domestication can constrain efforts to engage in economically viable and sustainable farm forestry practices. Thus, the crucial importance of education and training in developing the farming practices in these communities merits further attention if farm forestry activities are to be improved.

Concluding Remarks

These research findings have several implications for promoting and improving FF practices in the study areas. Promoters of FF can and should take advantage of the feeling of secured tenure arrangement and the influence of tree products on the household economy, to encourage farmers to diversify their agricultural crop systems to include more valuable tree species. This should be done by giving more attention to local priorities and constraints including credit issues. This study highlights some local preferences for tree species which were mainly exotic. Some of these exotic species particularly those reported in this study as priority species should be involved or promoted. While it is important to note farmers preferences for exotic tree species, efforts could also be made to do an economic comparison between these and local species and provide farmers with the information to make sound decisions. This should emphasize the environmental value in the use of indigenous trees, which from time immemorial are known to play an important role in food and nutritional supplements in the research areas. With more women than men having the responsibility for ensuring a good level of household food and income security in the area, the women should be an important target group in promoting FF development. They are more likely to influence improved FF adoption considering their role as decision-makers in their communities. However, greater attention to policy may be required to nurture the key role of women in farm forestry activities in the area.

Acknowledgments The Finnish Ministry of Foreign Affairs through ADRA-Finland financially supported the study. We acknowledge the help given to us by the local people involved in this study.

Appendix

Survey questions used to solicit information from farmers concerning their background, priority crops and tree species and constraints to and prospects for a wider implementation of farm-level tree planting.

Respondent's Identification

1. Location_____ 2. Sub-location_____

3. Clan_____ 4. village_____

Background Information

5. Sex a) Male☐ b) Female☐

6. Age a) Less than 20☐ b) 21-30☐ c) 31-40☐

d) 41-50☐ e) 51 and above☐

7. Marital status

a) Married☐ b) widow☐ c) widower☐

d) Separated☐ e) Single☐ d) other (specify)----------

8. Number of children

a) 1-3☐ b) 4-6☐ c) 7-9☐

d) 10 and above☐

9. Number of dependents

a) 1-3☐ b) 4-6☐ c) 7-9☐

d) 10 and above☐

10. Do you have any education?

a) Yes☐ b) No☐

11. If yes, indicate which level?

Production assets, activities and sources of income

12. What is your main occupation? --------Peasant farmer (growing food crops and livestock), ----Fisherman, --------Domestic worker, ---------Commercial farmer (cash crops/plantations),-------Labourer,.....-trading forest products etc.

13. How much do you earn per month from your main livelihood activities?

Income source	**Total cash income in Ksh**
Crops and livestock products(e.g. Millet, beans, maize, groundnut, cassava, sheep, cattle, goats, chicken, fish, etc	
Forest products (e.g. firewood, charcoal, fruit, flowers, spices, ropes, woodcrafts, honey, medicine, poles etc.	
Labour sale	
Others (specify) e.g. carpentry, domestic help, etc 1 2 3	

14. Do you own land?

a) Yes☐ b) No☐

15. If yes, is it adequate for your needs?

a) Yes☐ b) No☐

16. What is the size?

17. Do you feel secured on your land? (*Describe the ownership rights*)

a) Yes☐ b) No☐

18. If you do not own your land, what other tenure arrangements do you have?

19. Do you grow crops? (*How far is your farm from your home?*)

a) Yes☐ b) No☐

20. If yes, which ones?

a) Maize☐ b) Millet ☐ c) Cassava☐

d) Beans ☐ e) Others (Specify) ----------

21. If yes, for what purpose?

22. Do you keep any livestock?

a) Yes☐ b) No☐

23. If yes, which ones?

a) Cows☐ b) Goats☐ c) Sheep☐

d) chicken☐ g) Others (Specify)------

24. If yes, for what purpose?

25 Do you have trees on your farm? Planted or naturally generated?

26 Which trees species are preferred as farm tree? Name them in order of importance

Tree species	Uses / why is this species important?
1 2 3 etc.	

27. Which tree species are best suited for the following purposes? Indicate at least one tree species

Purpose	Name of species
Cash income	
Medicine	
Craft industry	
Furniture, timber and poles	
Fuel need	
Fodder	
Shade	
Soil fertility, erosion Controls	
Others:	

28. Who is responsible for the following roles in the household? Indicate with an 'X' in the column

Role type	Husband	Wife	Both	Entire family
Decision on income use				
Land preparation				
Planting and farm management				
Harvesting				
Marketing farm products				
Choosing farm crops and tree species				
Others				

29. Do you engage in tree nursery practices? a) Yes☐ b) No☐

30 What is your main source of water for domestic, nursery and other agricultural use? (e.g. lake, river, roof catchment, borehole etc..)

31 What is the source of labour for farming practices?

32. Is it difficult to get hired labour? a) Yes☐ b) No☐

Constraints to farm forestry adoption

33. What are the main hindrances to the implementation of integrated tree /crops/livestock systems? (List them in order of importance) ------- lack of rainfall, ------credit, --------Skills,.....educational background,.....diseases, ---------soil erosion,---------- land degradation --------land size ----- drought, tree seedlings.---------- Others (specify)----------

References

Appiah M (2001) Co-partnership in forest management: the Gwira-Banso joint forest management project in Ghana. Environ Dev Sustain 3(4):343–360

Appiah M, Blay D, Damnyag L, Dwomoh FK, Pappinen A (2007) Dependence on forest resources and tropical deforestation in Ghana. Environ Dev Sustain. doi:10.1007/s10668-007-9125-0

Barrett CB, Lynam J, Place F, Reardon T, Aboud AA (2002) Towards improved natural resource management in African agriculture. In: Barrett C, Place F, Aboud A (eds) Natural resource management in African agriculture. Undersigning and improving current practices. CAB Publishing, Wallingford, pp 287–296

Beentje HJ (1994) Kenya trees, shrubs, and lianas. National Museums of Kenya, Nairobi, ISBN 9966-9861-0-3

Biot Y, Blakie P, Jackson P, Palmer-Jones R (1995) Re-thinking research on land degradation in developing countries. World Bank Discussion paper 289. The World Bank, Washington

Blay D, Appiah M, Damnyag L, Dwomoh FK, Luukkanen O, Pappinen A (2008) Involving local farmers in rehabilitation of degraded tropical forests: some lessons from Ghana. Environ Dev Sustain 10:503–518. doi:10.1007/s10668-006-9077-9

Brooks TM, Pimm SL, Oyugi JO (1999) Time lag between deforestation and bird extinction in tropical forest fragments. Conserv Biol 13:1140–1150

Brown K (2002) Innovations for conservation and development. Geogr J 168:6–17

Brown K (2003) Three challenges for real people-centered conservation. Glob Ecol Biogeogr 12(2): 89–96

Castro AF (1991) Indigenous Kikuyu Agroforestry: a case study of Kirinyaga, Kenya. Hum Ecol 19(1): 1–18

Central Bureau of Statistics (2002) Kenya 1999 population and housing census. Ministry of Finance and Planning, Nairobi

Central Bureau of Statistics (2006) Kenya facts and figures. Nairobi Publishers, Kenya

Chambers R (1997) Whose reality counts? Putting the last first. Intermediate Technology Publications, London, 248 pp

Chambers R, Richards P (1995) Preface. In: Warren DM, Slikkerveer LJ, Brokensha D (eds) The cultural dimension of development: indigenous knowledge systems. Intermediate Technology Publications, London, pp xiii–xiv

Conelly WT, Chaiken MS (2000) Intensive farming, agro-diversity, and food security under conditions of extreme population pressure in western Kenya. Hum Ecol 28(1):19–51

Danida (1995) Danida sector policies for forestry and agroforestry

David S (1997) Household economy and traditional agroforestry systems in western Kenya. Agric Human Values 14:169–179
Dewees PA, Saxena NC (1995) Tree planting and household land and labour allocation: case studies from Kenya and India. In: Arnold JEM, Dewees PA (eds) Tree management in farmer strategies. Response to agricultural intensification. Oxford Science Publication, Oxford, pp 242–267
Ellis F (1998) Survey article: household strategies and rural livelihood diversification. J Dev Stud 35(1):1–38
Enters T, Hagmann J (1996) One-way, two way, which way? Extension workers: from messengers to facilitators. Unasylva 47:184
FAO (1990) Women in agricultural development: FAO's plan of action. Food and Agriculture Organization, Rome
FAO (1993) Forest resources assessment 1990. Tropical Countries, FAO forestry paper no. 112, Rome
FAO (2005) Global forest resources assessment, Country Report 180, Kenya. FAO, Rome
FAO (2007a) Food security district profiles. Food and Agriculture Organization, Rome
FAO (2007b) Kenya: intensified social forestry project; impact assessment report. Food and Agriculture Organization, Rome
Franzel S, Scherr SJ (2002) Trees on farms assessing the adoption potential of agroforestry practices in Africa. CABI Publishing, Nairobi, 197 p
Franzel S, Ndufa JK, Obonyo OC, Bekele TE, Coe R (2002) Farmer-designed agroforestry trials. Farmers experience in western Kenya, pp 111–119. In: Franzel S, Scherr SJ (eds) Trees on farms: assessing the adoption potential of agroforestry practices in Africa. CABI Publishing, Nairobi, 197 p
Freudenberger SK (1994) Tree and land tenure-rapid appraisal tools. FAO, Rome, 80 pp
Gebremedhin B, Swinton S (2003) Investment in soil conservation in northern Ethiopia: the role of land tenure security and public programs. Agric Econ 29:69–84
Government of Kenya (GoK) (2008) First medium term plan (2008–2012), Kenya Vision 2030, a globally competitive and prosperous Kenya. Ministry of State for Planning, National Development and Vision 2030, Nairobi, 218 p
Government of Kenya(GoK) (1989) The Land Control Act. Cap 302 of Laws of Kenya. Government Press, Nairobi
Guthiga P, Mburu J, Holm-Mueller K (2006). Cost benefit analysis of different management approaches of Kakamega forest, Kenya. In: Conference proceedings of "8th Bioecon conference". Kings College, Cambridge
Hesselberg J, Yaro JA (2006) An assessment of the extent and causes of food insecurity in northern Ghana using a livelihood vulnerability framework. GeoJournal 67:41–55. doi:10.1007/s10708-006-9007-2
Imo M, Ogweno DO, Matano A, Orinda B (2001) Adoption of agroforestry and improved land use practices in Kipkaren river catchment, Kenya. In: 1st National scientific conference, Lake Victoria Environmental Management Project, Kisumu, 15–19 Oct 2001
Jama BA, Niang IA, Amadalo B, De wolf J, Rao MR, Buresh RJ (1999) The potential of improved fallows to improve and conserve the fertility of nutrient depleted soils of western Kenya. In: Proceedings of the 6th Biennial KARI Scientific Conference (KARI), pp 133–144
Kaudia AA, Omoro LMA (2001) Is the 'technical expert' role of farm forestry extension agents fading? Recent experiences from Africa and implications for future extension programs, Forest Extension, International Union of Forestry Research Organizations, www.regional.org.au/au/iufro/2001/kaudia.htm
Kenya Forestry Master Plan (1994) Development programmes. Ministry of Environment and Natural Resources, Nairobi
Kiptot E, Franzel S, Hebinck P (2006) Sharing seed and knowledge: farmer to farmer dissemination of agroforestry technologies in western Kenya. Agrofor Syst 68:167–179
Kirby KR, Potvin C (2007) Variation in carbon storage among tree species: implications for the management of a small-scale carbon sink project. For Ecol Manag 246:208–221
Kokwaro JO (1993) Medicinal plants of East Africa', 2nd edn. Kenya Literature Bureau, Nairobi, ISBN 9966-44-190-5
Krishna A (2001) Moving from the stock pf social capital to the flow of benefits: the role of agency. World Dev 29:925–943
Lutz E, Pagiola S, Reiche C (1994) The costs and benefits of soil conservation: the farmers' viewpoint. World Bank Res Obs 9(2):273–295

Macqueen DJ (1991) Exploration and collection of *Calliandra calothyrsus* as a foundation for future genetic improvement. Nitrogen Fixing Tree Res Rep 9:96–98
Maithya JM, Kimenye LN, Mugivane FI, Ramisch JJ (2006) Profitability of agro-forestry based soil fertility management technologies: the case of small holder food production in Western Kenya'. Nutr Cycl Agroecosyst 76:355–367
Mbuvi D, Boon E (2009) The livelihood potential of non-wood forest products: the case of Mbooni Division in Makuenni District, Kenya. Environ Dev Sustain 11:989–1004
McCarthey J (2004) 'Viewpoint—community forestry: a few sympathetic, but critical questions'. Bulletin of the Global Caucus on Community Based Forest Management, Fall 2004 issue, 11–12
Muchiri MN, Pukkala T, Miina J (2002) Modelling trees' effect on maize in the Grevillea Robusta + maize systems in Central Kenya. Agrofor Syst 55:113–123
Mulinge M, Mueller CW (1998) Employee job satisfaction in developing countries: the case of Kenya. World Dev 26(12):2181–2199
Müller D, Mburu J (2009) Forecasting hotspots of forest clearing in Kakamega, Western Kenya. For Ecol Manag 257:968–977
Mungai DN, Coulson CL, Stigter CJ, Ng'ang'a JK, Mugendi DN (2001) Phenotypic nutrient up-take differences in an alley cropping system in semi-arid Machakos, Kenya. J Environ Sci 13(2):164–169
Murniati, Garrity DP, Gintings AN (2001) The contribution of agroforestry systems to reducing farmers' dependence on the resources of adjacent national parks: a case study from Sumatra, Indonesia. Agrofor Syst 52:171–184
Nair PKR (2001) Do tropical homegardens elude science, or is it the other way around? Agrofor Syst 53(2):239–245
Nyangena W (2008) Social determinants of soil and water conservation in rural Kenya. Environ Dev Sustain 10:745–767
Ogato GS, Boon EK, Subramani J (2009) Gender roles in crop production and management practices: a case study of three rural communities in Ambo District, Ethiopia. J Hum Ecol 27(1):1–20
Okitoi LO, Ondwasy HO, Obali MP, Murekefu F (2007) Gender issues in poultry production in rural households of Western Kenya. Livestock Research for Rural Development. Vol 19, Article #17. Retrieved 5 March 2010 from http://www.lrrd.org/lrrd19/2/okit19017.htm
Oluoko-Odingo AA (2008) Determinants of poverty: lessons from Kenya. GeoJournal 74(4):311–331. doi:10.1007/s10708-008-9238-5
Pretty J (1995) Participatory learning for sustainable agriculture. World Dev 23(8):1247–1263
Radersma S, Otieno H, Atta-Krah AN, Niang AI (2004) System performance analysis of an alley-cropping system in Western Kenya and its explanation by nutrient balances and uptake processes. Agric Ecosyst Environ 104:631–652
Ramadhania T, Otsyinab R, Franzel S (2002) Improving household incomes and reducing deforestation using rotational woodlots in Tabora District, Tanzania. Agric Ecosyst Environ 89(3):229–239. doi: 10.1016/S0167-8809(01)00165-7
Sanchez PA, Jama BA (2000) Soil fertility replenishment takes off in East and Southern Africa. ICRAF, Nairobi
Shelton HM, Lowry JB, Gutterridge RC, Bray RA, Wildin JH (1991) Sustaining productive pastures in the tropics: tree and shrub legumes in improved pastures. Trop Grasslands 25:119–128
Torquebiau EF (2000) A renewed perspective on agroforestry concepts and classification Comptes Rendus de l'Académie des Sciences—series III. Sci de la Vie 323(11):1009–1017
Wiersum KF (1991) Soil erosion and conservation. In: Avery ME, Chin KO (eds) Biophysical research for Asian agroforestry. Winrock International, USA, 292 p
World Bank (1996) African development indicators. World Bank, Washington